

WHAT IS CLAIMED IS:

*Sub B1* 1. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force at an upper stream of a valve sheet to a fuel passing through  
5 a surrounding area of a valve body and a nozzle injecting a swirling fuel,

wherein a fuel spray injected out from an injection port of said nozzle is so formed that an orientation of said fuel spray is deflected in a definite direction on a basis of a  
10 longitudinal axis of a fuel injection valve body, a reachable distance of said fuel spray at a deflected side is longer and a reachable distance of said fuel spray at another side opposite to a deflected side is shorter.

15 2. A fuel injection valve of Claim 1, wherein measured under atmospheric pressure, a spray deflection angle with respect to a center line C of said fuel injection valve body is from  $5^{\circ}$  to  $10^{\circ}$ , a ratio of a reachable distance L1 of a spray at a deflected side and a reachable distance L2 of a spray at  
20 another side opposite to a deflected side,  $L1/L2$ , is from 1.1 to 1.4, and a fuel spray angle is from  $70^{\circ}$  to  $90^{\circ}$ .

*Sub B2* 3. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force

at an upper stream of a valve sheet to a fuel passing through a surrounding area of a valve body and a nozzle injecting a swirling fuel,

wherein said fuel injection valve body is mounted on a top position of a cylinder with such an angle as a longitudinal axis C of said fuel injection valve body intersects diagonally a longitudinal axis of a cylinder, and

an injection port of said nozzle facing to an inside of said cylinder has a deflection angle toward an ignition plug side placed inside said cylinder with respect to said longitudinal axis of a fuel injection valve body.

4. A fuel injection valve of Claim 3, wherein an deflection angle of said injection port with respect to said longitudinal axis of a fuel injection valve body is between 5° and 10°.

*Sub B3* 5. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force at an upper stream of a valve sheet to a fuel passing through a surrounding area of a valve body and a nozzle injecting a swirling fuel,

wherein said fuel injection valve body is mounted on a top position of a cylinder with such an angle as a longitudinal axis C of said fuel injection valve body intersects diagonally

a longitudinal axis of a cylinder,

an injection port of said nozzle facing to an inside of said cylinder has a deflection angle toward an ignition plug side placed inside said cylinder with respect to said longitudinal axis of a fuel injection valve body, and

a distance from a valve body contact position of said valve sheet to an outlet of an injection port of said nozzle at the deflection side is made shorter and a distance from a valve body contact position of said valve sheet to an outlet of an injection port of said nozzle at a non-deflection side is made longer.

6. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force at an upper stream of a valve sheet to a fuel passing through a surrounding area of a valve body and a nozzle injecting a swirling fuel,

wherein said fuel injection valve body is mounted on a top position of a cylinder with such an angle as a longitudinal axis C of said fuel injection valve body intersects diagonally a longitudinal axis of a cylinder,

a marginal part of an outlet of an injection port of said nozzle is formed as a non-vertical slant with respect to a longitudinal axis of a fuel injection valve body, and

assuming for a marginal part of an outlet that a slant face extended out from a face of an outlet of an injection port toward injection direction is defined as a slant face upstream side and a slant face extended back from a face of an outlet of an injection port toward an opposite direction to said injection direction is defined as a slant face down stream side, a slant face down stream side of a marginal part of an outlet of an injection port is made directed toward an ignition plug side and a slant face upstream side of a marginal part of an outlet of an injection port is made directed toward an opposite side to an ignition plug side.

7. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force at an upper stream of a valve sheet to a fuel passing through a surrounding area of a valve body and a nozzle injecting a swirling fuel,

wherein a small raised part with a height shorter than a length of an orifice of an injection port is formed at a center of an external face of a bottom part of a nozzle having an injection port,

said injection port has a inclination with respect to a longitudinal axis of a fuel injection valve body and its outlet is formed at said small raised part, and said small

raised part defines a wall part of a marginal part of an outlet of said injection port 17, and

a top face of said small raised part provides such a slant face as a deflected direction side of an injection port is made lower and its non-deflected direction side is made higher in view of an outlet of said injection port from said valve sheet.

8. A fuel injection valve of Claim 7, wherein said small raised part is composed of an outline enclosed by a circular arc with its face perpendicular to a center line of said small raised part larger than a semi-circumference and a chord connected between its both ends,

a top face of said small raised part is made to be a slant face by means that a height of said small raised part at said chord side is made to be higher and a height of said small raised part at an opposite side to said chord side,

said injection port is so constructed that an inlet side of an injection port may be deflected toward said chord side with respect to a center line of said small raised part, and that an outlet side of said injection port is deflected toward an opposite side of said chord side.

9. A fuel injection valve of any one of Claims 1 to 8, wherein an intersection between said longitudinal axis of a

fuel injection valve body and a center line of said injection port is located inside an orifice structuring said injection port.

5 10. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force at an upper stream of a valve sheet to a fuel passing through a surrounding area of a valve body and a nozzle injecting a swirling fuel,

10 wherein a plane of an outlet of an injection port of said nozzle is slanted with respect to a vertical face perpendicular to a center line of said injection port.

11. A fuel injection valve for an in-cylinder injection type  
15 engine having a fuel swirling means for giving a swirling force at an upper stream of a valve sheet to a fuel passing through a surrounding area of a valve body and a nozzle injecting a swirling fuel,

Wherein an injection port is mounted on said nozzle so  
20 as to be offset with respect to a longitudinal axis of an injection valve body.

12. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force

at an upper stream of a valve sheet to a fuel passing through a surrounding area of a valve body and a nozzle injecting a swirling fuel,

wherein a valve sheet, an injection port located at a  
5 down stream of said valve sheet and a fuel swirling space located between said injection port and said valve sheet are formed at a nozzle,

said injection port has a slant with respect to a longitudinal axis of a fuel injection valve body,

10 said fuel swirling space is defined so as to be axial symmetry with respect to a longitudinal axis of a fuel injection valve body, and

a center of an inlet of said injection port is offset with respect to a longitudinal axis of said fuel injection valve  
15 body.

13. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force at an upper stream of a valve sheet to a fuel passing through  
20 a surrounding area of a valve body and a nozzle injecting a swirling fuel,

wherein a concave portion shaped in a reverse-cone and having a curved surface on its top of a reverse-cone is formed on an inner surface at a center part of a top of a body of said

nozzle by press work,

a valve sheet is formed on a surface of said concave portion,

a semispherical small raised part is formed by press work  
5 at said central part of an outer surface of a body top of said nozzle, and

a fuel injection port is formed at a thick part of said small raised part so as to be slanted with respect to a longitudinal axis of a fuel injection valve body.

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14. A fuel injection valve of any one of Claims 1 to 8, wherein assuming that a length of said injection port is defined as  $l$  and a diameter of said injection port is defined as  $d$ , those parameters are determined so as to satisfy a relational  
15 expression  $0.3 < l/d < 1.3$ .

15. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force at an upper stream of a valve sheet to a fuel passing through  
20 a surrounding area of a valve body and a nozzle injecting a swirling fuel,

wherein assuming that a top of said valve body contacting to said valve sheet when a valve is closed faces to an inlet of said injection port at a down stream of a valve sheet, and



that a distance from a position at which said valve body contacts said valve sheet to an inlet of said injection port is defined as  $y$ , and a distance from a position at which said valve contacts said valve sheet to an inlet of said injection port and a top of said valve body is defined as  $z$ , a condition to be required is  $y \leq 2z$

16. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force at an upper stream of a valve sheet to a fuel passing through a surrounding area of a valve body and a nozzle injecting a swirling fuel,

wherein it is so defined that a valve body contacting said valve sheet when a valve opens is shaped in a sphere, and that a top of a sphere of said valve body is located as a same position as an inlet of said injection port or gets into an inside of said injection port when a valve is closed.

17. A fuel injection valve for an in-cylinder injection type engine having a fuel swirling means for giving a swirling force at an upper stream of a valve sheet to a fuel passing through a surrounding area of a valve body and a nozzle injecting a swirling fuel,

wherein said nozzle is formed with an orifice used as an

injection port located at a center of a bottom part of a body having a bottom and shaped in a hollow cylinder and with a valve sheet located at an upper stream of said orifice,

5 said fuel swirling means has a guide hole for said valve body at its center and is composed of a chip having an eccentric fuel channel at its outer face and bottom face,

said chip is supported by an inner bottom of said nozzle and inserted into said nozzle,

10 a diameter of an inner surface of said nozzle is enlarged at a region from a corner intersecting an inner bottom face of said nozzle to an inside perimeter position intersecting a vertical face of a chip axis at a middle position in a height of said chip, and

15 a hollow is formed at a corner intersecting an inner bottom face of said nozzle positioned below a face accepting a chip of an nozzle inner bottom in a region of said inner enlarged perimeter.